B0269-instructions,TM2030

USER'S INSTRUCTIONS FOR
TRI-METRIC ™
Battery system monitors Model TM-2030-RV and TM-2030-A

INSTALLERS: See separate TriMetric TM-2030 **installation** instructions

revised March 18, 2014. Later revisions will appear on our web site.

Essential information for users: read pages 2-4

1. Overview of TM-2030-RV or TM2030-A battery system monitor
2. Basic instructions for Operating Level L1
   - 2.1 More details on the five less used display items
   - 2.2 What are Battery Reminders?
   - 2.3 Who might want to use operational level L2 or L3?

Additional information and reference

3. Instructions for Operating Levels L2 and L3.
4. History data available with the TM-2030
5. Summary of Programming instructions
6. Reference section
   - 6.1. Warranty and Specifications
   - 6.2 How the TriMetric keeps track of Battery % full
   - 6.3. History data can be useful for diagnosing battery system problems.
   - 6.4 Further description of each programming function

Bonus information on battery care

7. Important information on how to keep from killing your batteries.

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1. **Overview of TM-2030-RV and TM-2030-A battery system monitor/solar controller**

The TM 2030 is intended to keep you informed about 12V to 48V battery systems, such as ones found in RV's or off grid homes—which are regularly charged and discharged and use "deep cycle" batteries**.**

The TM2030 may also be used with the new, optional Bogart Engineering SC-2030 30 amp solar charger. These two will together allow both flexible and accurate solar charging and comprehensive monitoring of batteries.

How the TM-2030 can be useful to you;

The "**amps**" or "**watts**" display measures the rate of energy going in or out of your batteries so you can check your charging systems, and also to see how much energy each of your appliances use to help you conserve energy. The **"% Full**" display is the most accurate way to keep track of how charged or discharged your batteries are until battery volts gets really low. When battery volts goes below 11.5 volts, (for 12 volt systems) the "**volts**" display can warn that you are near discharge. The "volts" display also lets you discover if your charger is charging to a voltage neither too high or too low, (also see data logging below) which is important for maximizing your battery life. The "**days since charged**" display shows how recently the main battery (system) was fully charged, so if it hasn't been charged recently you can perform extra charging if necessary to help maintain the capacity of your batteries. The TM-2030 also can measure **voltage only** of a second battery set, such as the motor starting battery, or solar voltage input to an MPPT charge controller.

New to the TM-2030: an **audible alarm will signal a low battery.** A new display shows **Replaced Percentage (rPC):** shows how much of the most recent discharge has been replaced to your batteries during the next day's charging. Ideally this should reach 110% or even more.

Data logging: Important information to check settings on your charger: For each of the last 5 days the **daily maximum battery voltage** level, and **minimum charging amps** is recorded as well as the **percent of overcharge** achieved. Many battery companies say proper overcharge is important for battery maintenance. It also logs for **up to five of the most recent charge/discharge cycles**: **cycle length**, **charge efficiency, minimum battery% full** and **minimum voltage level** for each cycle. This is useful diagnostic information which a technician can use to determine that your whole system is working properly.

Serial data output: For extreme techies only: The TM-2030 also has a serial 0-5V output with streaming "real time" serial (ASCII) data that could be used to control other electronics. This is described on our website: www.bogartengineering.com.

You may select 4 Operating Levels at which this meter will operate: Level L1, L2 , L3 or L4. It is factory set to Level L1, the basic level suitable for most users and recommended for starting. Section 2 of this manual describes the operation for level L1. L2 allows observing Data Logging. Levels L3 and l4 allow additional functions described page 2: *Who might want to use operational level L2 ,L3 or L4*.

IMPORTANT: Be sure that the installer of this meter has installed correct programmed parameters into this meter, as described in "Installation instructions for TriMetric TM-2030" section C1, otherwise this meter will not give correct data on "Battery % full" and "days since charged"

2. Basic instructions for Operating Level L1: Refer to figure 1 which covers basic operation. It also has references for further information. **Note that "% full" will display only 3 dashes until system is fully charged for the first time.**

2.1 More details on the five less used display items (which you may not need to know):

AH This is the measure of Amp hours from a full battery. See section **6.2: How the TriMetric keeps track of battery % full** for a description of how this is measured. This is just another way to look at the "% full" data. For this number to be accurate you must set Program numbers P1, P2, P3 as described in separate instructions: "Installer's Instructions for TriMetric TM-2030." If you use this meter at Level L3 then also P10 and P14 must be correct. Continued page 3

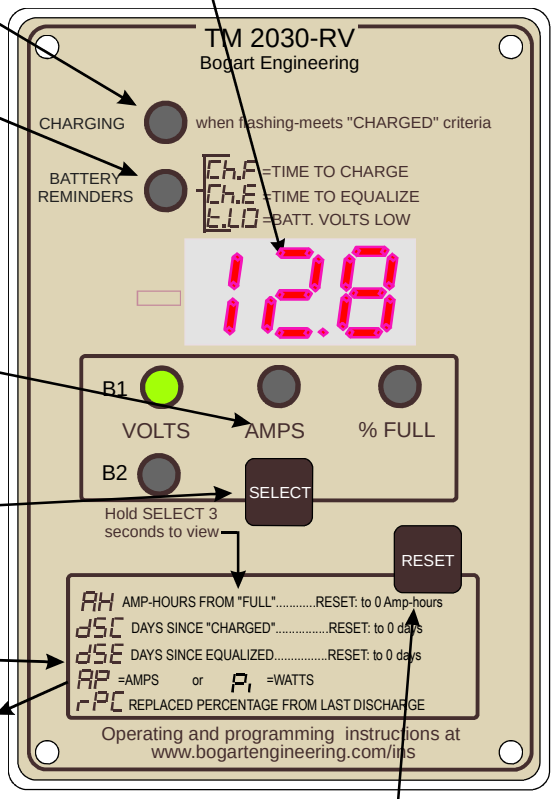
IMPORTANT DISPLAY NOTE:
Flashing decimal point means “multiply the number seen by 1000”

CHARGING LIGHT:
When lighted shows “battery 1 is charging” (“amps” or “watts” is positive)
Flashing lamp means battery is charged.

BATTERY REMINDERS:
Lamp flashes and display occasionally shows these letters when:
battery should be recharged “Ch.F”
or “battery should be equalized” “Ch.E”
or “battery voltage low” “b.LO”
See section 2.2 for details

DO YOU PREFER “AMPS” OR “WATTS” to show in primary display?
See Table 2, Program P4, to change

TO ACCESS PRIMARY (MOST OFTEN USED) DISPLAYS
Push **“SELECT”** quickly to make display toggle through:
VOLTS (first battery B2, then battery B1)
AMPS (or WATTS) entering(+) or leaving(-) battery B1
%FULL (for battery 1) Battery B1 must be charged fully at least once before this will display.



TO ACCESS SECONDARY (LESS OFTEN USED) DISPLAYS
Push and hold **“SELECT”** for 3 seconds until "**AH**" pops into display. Immediately release "SELECT". You will see:

AH = Amp-hours discharged from a full battery.

Push "SELECT" quickly to toggle through:

dSC= Number of days since the batteries have been fully charged

dSE= Number of days since the batteries have been equalized (if used)

AP or **Pr** = Shows amps or watts entering/leaving the batteries
Amps : “**AP**” or Watts: “**Pr**”

rPC Shows how much energy you’ve replaced of the last discharge
See Section 2.1 for more details on these 5 items.

TO ACCESS PROGRAM OR HISTORY DATA:
Hold SELECT down and watch for “**P**” (Program) or “**H**”(History) at left in display, then release SELECT. See sections 5 and 6.4 for details on **program** data. See sections 4 and 6.3 on **history** data.

NOT SURE WHERE YOU ARE? Push SELECT repeatedly until you get back home.

RESET button:
To RESET any of these: (1) Use SELECT to view it on display. (2) Push and hold RESET for 5 seconds.
The **RESET** button will reset any of the following:
“Batt% full” (to 100%)
Amp Hours from full (to 0 Ahr)
Days since charged (to 0 days)
Days since equalized (to 0 days)

FIGURE 1 TM-2030 Operation Summary
Shows view of TM-2030-RV, but TM-2030-A operation is identical.

dSC Shows the **number of days since the battery has been fully charged**. This display gradually increases by 1.00 every day until the battery is charged, at which time this value is automatically reset to 0.00. To understand precisely what the TriMetric considers "charged", refer to section **6.2: How the TriMetric keeps track of Battery%Full.** For this number to be correct, Program values P1 and P2 must be correct as described in "Installer's Instructions for TriMetric TM-2030."

dSE Days since the battery was equalized. "Equalization" refers to occasionally overcharging a battery to help it maintain its capacity. It is usually recommended only for liquid electrolyte lead acid batteries, not AGM or Gel types. This display is intended to remind you when to equalize your batteries if this is not done automatically by your charging system. It is essentially just a manual timer, that reads in DAYS, so that you can see how long it has been since your batteries were equalized. Each day when not reset it will advance by 1.00 day. Then it must be MANUALLY RESET by you when you take action to equalize the batteries. For how to reset this, refer to Figure 1, in reference to the RESET button.

A or **Pr (A** shows **Amps**, **Pr** shows **Watts)** This shows either AMPS or WATTS, depending on what has been programmed in P4 (see table 2 on page 6). If the primary display shows AMPS then this one will show WATTS. And vice versa

rPC: "**Replaced Percentage** of recently discharged energy. (Not the same as % full, above.) This shows the percentage of charge that is being replaced--compared to the amount that was recently removed during the *last* discharge cycle. When discharging this display shows 0. When charging it increases--when it shows 100% it has replaced the same amp hours that was last removed. To preserve capacity of liquid lead acid batteries it is often recommended to overcharge to 110-120% before going into "float". For AGM batteries to 103-108%.

2.2 What are Battery Reminders?

This is an *optional* feature that is designed to help you keep your batteries maintained, which can remind you to periodically charge your batteries to maximize their life. It comes from the factory turned OFF. More detailed information about the need for proper charging can be found in section 7 of these instructions: **Important information on how to keep from killing your batteries**.

At basic Operating level L1, there are two reminders which you can invoke if you wish:

2.2.1 "**Ch.F**" (**Ch**arge **F**ull) Reminder to charge batteries fully if they haven't been charged in several days. You can choose how many days. Lead acid batteries need to be frequently fully charged, otherwise they will lose capacity. We recommend no longer than about 5 days. If you set it for 5 days (using Program number P5—see Table 2) then if 5 days pass without fully charging the batteries the message "Ch.F" will occasionally blink in the display, until batteries are again fully charged.

2.2.2. "**Ch.E**" (**Ch**arge **E**qualize) Reminder to equalize batteries occasionally, (typically monthly) if recommended by the battery manufacturer. Equalization refers to an occasional overcharge which is recommended by manufacturers of "liquid electrolyte" batteries (the ones with watering holes on top.) It is not ordinarily recommended for AGM or Gel type (VRLA) batteries. If you have liquid electrolyte batteries, and if you need to manually equalize, you can choose the equalization reminder interval (for example, once every 30 days) to flash "**Ch.E**" in the display after this interval. This feature is intended to remind you to equalize at regular intervals if equalization is not accomplished automatically by your charger or charge controller. Then, after you accomplish equalization you must manually reset the "Days since equalize" number as described in figure 1, by the RESET button. More information about equalization may be found in section 7: **Important information on how to keep from killing your batteries**. The number of days is programmed by Program P6. (See Table 2).

2.3 Who might want to use operational level L2 or L3? (See section 3)

Level 2 will allow *observing* the History data (always being recorded)—see page 5

Level 3 will allow these additional functions:

- Allows addition of the optional Bogart Engineering SC-2030 30 Amp solar charger for your batteries.
- Allows setting up the audible and visual "low battery" alarm. (Table 3, P9 and P13)
- Using a 100A/100mV shunt instead of the more usual 500A/50mV shunt (see Table 3, P11)
- Allow disabling the "automatic reset" when the batteries are charged. (see Table 3, P12)
- Choice of "efficiency factor" different from the default 94% (see Table 3, P10 and Section 6.2)
- Allows additional "minimum time" to maintain voltage and amps "charged" criteria. (see Table 3 ,P14)
- Calibrate the battery voltage (see Table 3, P18)
- Allows observation of "filtered" values of volts and amps, used for determining when batteries are "charged". (See section 3 and section 6.2, step5)

3. Instructions for Operating levels L2, L3 L4. To change: see Table 2, program P7.

Level L2 has all the functions of L1, but also allows access to some history information (see below) for those who wish to keep better track of their battery system. It is intended to help technicians in analyzing systems to see that they are operating properly. Also see Section 4 and section 6.3.

Level L3 and L4 have all functions of L2, and also adds additional programming functions summarized in Table 3 and detailed in section 2.3 and 6.4.. Also, Level L3 and L4 allow you to observe the "filtered values" of "**Volts B1**" or "**Amps**" (which are extremely sluggish versions of these items) by pushing and holding the **RESET** button while viewing "**VoltsB1**" or "**Amps**". The meaning of the filtered values is described in section 6.2, step 5.

The difference between L3 and L4 is that the L4 level raises the requirement for a "charged" battery--beyond the usual volts/amps requirement.(see Section 6.2). The additional requirement is that the battery must meet the "float" requirement. defined for the SC-2030 charger. Not recommended unless you understand the requirement.

4. History data available with the TM-2030. Table 1 below summarizes the 36 items of history data. It is available at Operating Levels L2 , L3 or L4. These are useful for a technician to determine if your system is working properly, or to diagnose a battery system problem.

To view the History data: Go to page 16 (last page of these instructions) which describes how to access this data, which you can write into the chart on that page. Section 6.3, on page 9 has a description of the three different types of data: (1): **H1** (Total cumulative battery amp hours). , (2): **H2 through H6** (Last five charge cycle's data), and (3): **H7-H9** (Last five day's data).

On the chart for the **H2-H6 data** each column represents a different **charge/discharge** cycle. For the **H7-H9** data each column represents a **different day**. In both cases the leftmost column is the most recent data, and the rightmost column is the oldest data.

The last five day's data (H7-H9 data below) is particularly useful for determining whether your chargers are charging to correct voltage and current—or to find out why the meter has not been meeting the "charged criteria" when you think

Display Identifier	No. of items	Summary History Description (also see section 6.3)
H1	**1**	**Cumulative lifetime battery (discharging) amp hours.** Analogous to a car odometer, this display shows how much wear has occurred on your batteries due to the repeated cycling of your battery system. Every time you remove energy from your batteries this display records the amp hours you are taking out, but it does NOT record the charging amp hours when you charge. In this way it measures the wear caused by the discharging and charging chemical activity on the battery over its lifetime. **RESET to ZERO** by pushing and holding RESET **for 4 seconds** while displaying this data.
H2.1-2.5	**5**	**For last 5 charge/discharge cycles*:** Hours since the end of each cycle.
H3.1-3.5	**5**	**For last 5 charge/discharge cycles***: Length of each cycle, hours.
H4.1-4.5	**5**	**For last 5 charge/discharge cycles***: Charge efficiency measurement: Shows how much more amp hours to charge compared to last discharge (in percentage) for entire last discharge/charge cycle.
H5.1-5.5	**5**	**For last 5 charge/discharge cycles***: Lowest % Full value during each cycle.
H6.1-6.5	**5**	**For last 5 charge/discharge cycles***: Lowest battery voltage for each cycle.
H7.1-7.5	**5**	**For last 5 days:** Highest battery (B1) voltage attained for each day
H8.1-8.5	**5**	**For last 5 days:** If "highest voltage (H7) was **less** than "charged voltage setpoint" then this shows **amps value** while voltage was highest. If "highest voltage (H7) **exceeded** "charged voltage setpoint" then this shows the **lowest amps value** during time that voltage was above setpoint. **Purpose:** To show how close it got to voltage/amp charged setpoints.
H8.1-8.5	**5**	**For last 5 days: shows how much charge has been returned on this day, compared with the last discharge: expressed as a percentage.**
H9.1-9.5	**5**	**For last 5 days: shows how much charge percent was replaced on that day, compared to last discharge.**
TABLE 1. See section 6.3 for more details		

***A charge/discharge cycle refers to the time beginning from a fully charged battery, followed by partial discharge (to less than 98%), and ending when charging it back up to "charged" again. Data is displayed only when discharge again goes below 98%.**

5. Summary of Programming instructions

Program functions applicable for Operating Level L1 are summarized in Table 2 below. As mentioned above, **it is most important that items P1, P2 and P3 (below in Table 1) be correctly programmed for the Batery%Full data to be correct.** Step by step procedure for doing this is described in the "Installer's Instructions for TriMetric 2030. The additional functions applicable to level L3 are summarized in Table 3 below. If you need more information than given in Tables 2 or 3, look at references in section 6.4 of these instructions.

To **observe** program data follow steps 1 and 2.

To **change** program data follow additional steps 3 and 4.

(1) HOLD DOWN the SELECT button and watch as the display cycles through several different displays. When you see **P1** in the display, immediately release SELECT. If you don't release quickly enough, just wait longer holding down SELECT until you see the **P1** again, then release. Then the "**Charged" setpoint voltage** (first item shown in table below) will alternate with "**P1**", so you can observe its value.

(2) Push SELECT repeatedly to observe **programmable data** P2, P3, etc, as shown in the left two columns below. After going through all these it will go back to observing normal display data. (Volts, Amps, etc.)

(3) If during step 2 you see **programmable data** that you wish to CHANGE, push both **SELECT and RESET briefly, but firmly at the same time**. Three green lamps will flash to indicate that you can now change the data. Successive pushes to RESET will increase the numbers slowly. Hold RESET down longer to speed up the change—this will cause data to cycle more quickly through all the possibilities. To make values go down, you will need to keep increasing until it finally jumps to its lowest value again.

(4) When satisfied with the **programmable data**, push SELECT to get back into OBSERVE mode. Now either continue programming as described in step 2, or to get back to regular displays, push SELECT repeatedly.

PROGRAM MODE NUMBER *Used by SC-2030 charger	**PROGRAMMABLE DATA and ADJUSTMENT RANGE**	Factory value / Your value	**WHAT IT IS FOR (SUMMARY) For more information, see Section 6.4**
***P1**	"Charged" setpoint voltage. **10.0** to **65.0** volts	**28.6**	TriMetric determines that battery is charged when actual volts is *greater* than setpoint voltage, and amps is *less* than setpoint amps. When this is true the "charging" lamp flashes to indicate a full battery. This resets "amp hours from full" to 0 and "battery % full" to 100%, and the "Days since charged" to 0 **Also see section 6.2**
***P2**	"Charged" setpoint amps multiplier, in % **0.1** to **10** percent of the value of "battery capacity," P3. If this value is 02, and P3=400, setpoint amps=2% of 400 =8 amps..	**02**	
***P3**	"Battery capacity" amp-hours **10** to **10,000** amp hours. **Note: flashing decimal point means "multiply number by 1000";** so 1.02 means 1020 amp hours	**400**	Enter the battery capacity in amp hours. This setting influences only the "Battery % full" display numbers and uses this information to display this % value correctly for your batteries. **Also see section 6.2**
P4	WATTS or AMPS choice **Pr**= WATTS, **A**=Amps	**A**	Chooses whether AMPS or WATTS shows up on the Primary display, just after "B1 volts". If you choose AMPS, then WATTS shows on the secondary display. And vice versa.
P5	Days before "time to recharge" reminder **1-100** days, or **OFF**	**OFF**	When "Days since charged" equals or exceeds this number, "time to recharge"(cH.F) reminder will flash periodically in display. **Also see section 2.2**
P6	Days before "time to equalize" reminder. **1-100** days, or **OFF**.	**OFF**	When "Days since equalized" exceeds this, "time to equalize (cH.E) reminder will display. **See also section 2.2**
P7	Chooses Operational level; Choose **L1, L2** or **L3**.	**L1**	L1 is simplest level. L2=next level: shows historical data L3 Shows all of L1 and L2 plus additional programming options**.**

TABLE 2. Program modes for Operating level "L1" (simplest)

PROGRAM MODE NUMBER *Used by SC-2030 charger	**PROGRAMMABLE DATA and ADJUSTMENT RANGE**	Factory (and L1,L2) value. write your value here	**WHAT IT IS FOR (SUMMARY) Where to find more information.**
P9	Low Battery Audible Alarm Setpoint **0ff** or **1-100** percent	**OFF**	When not OFF, audible alarm will sound and "battery reminder" (**bLO**) will flash when "% full" is less than this value, or if battery "volts" less than P13 setting.
P10	Assumed efficiency factor **60** to **100** percent	**94**	When meter calculates amp hours: Discharging always decreases amp-hrs at 100% rate. When charging increases amp hours at this specified percent rate. **Also see section 6.2 step 4.**
P11	Shunt type: **Sh.H** = 500A/50mV shunt **Sh.L** = 100A/100mV shunt	**Sh.H**	Shunt type for correct Amps and amp hour values. **Also see section 6.4, P11**
P12	Automatic reset **ON** **OFF**	**ON**	When "ON", Batt % full reset to 100, and Amp-hrs reset to 0 when Charge criteria are met: P1, P2 and P14. **Also see section 6.2 Step 3, and section 6.4, P12.**
P13	Battery low volts alarm: **10.0-65.0** volts	**10.0**	When volts is at or lower than this value, "b.LO" flashes occasionally in display as "battery reminder." Also audible alarm occurs when P9 is not "OFF". **Also see section 2.2.3 and section 6.4, P13.** .
*P14	Additional required time that the "charged" critera be met, besides P1 and P2 above.; **0.0 – 5.0** hours	**0.0**	If not zero, this will impose an **additional** time both "charged" criteria in P1,P2 must be met before batteries are "charged". **See section 6.2 step 4 and section 6.4, P14.**
*P15	Max. voltage allowed during." finish charge" stage. **10.0-65.0** volts		Used only by SC-2030 charger
*P16	Float voltage **10.0-65.0** volts		Used only by SC-2030 charger
P17	Time before daily maximum measurement will be recorded. **0-23** hours	(N/A)	For history data: H7 and H8 (only): Adjust this to number of hours after present time that daily measurement should be recorded. (Usually to occur late at night). **Also see section 6.4, P17**.
P18	Voltage calibrate. Set to correct batt voltage	(N/A	This allows slight adjustment of battery voltage. Use accurate digital voltmeter and adjust to that value. HOLD RESET to INCREASE. Push RESET repeatedly to DECREASE. **Also see section 6.4, P18**
P19	Program all factory values		Sets all values shown as "Factory values" in this table. Hold RESET for about 4 seconds to accomplish. **Also see section 6.4, P19**
*P20	Percent overcharge before float. **0-20** %		Used only by SC-2030 charger
*P21	Percent of P3 to which "amps" is limited during "finish charge". **0-10**%		Used only by SC-2030 charger
*P22	One button auto entry of eight most important program data. Profiles: **1-31**		Allows quick entry of all or most program data, especially when used with SC-2030 charge controller

TABLE 3. Additional program modes for Operating Level "L3 and L4"

6. Reference section: more technical information: ●warranty and specficiations, ●How TriMetric keeps track of battery % full, ●Using History data, ●Programming function descriptions

6.1 TM-2030 Warranty and Specifications

Warranty: 4 years if not obviously abused: We will repair or replace (at our option) to operate at a level specified or implied by our instructions.

Main battery (B1): Measures Volts, Amps, Watts, Battery % Full, Amp-hours from full, Days since charged, Timer for days since Equalized. Also data logging (history data) described below.

Secondary Battery (B2) sharing common negative with main battery: Measures volts only

Battery Volts: From 10.0 – 65.0 volts for main battery. From 0.0 to 100 volts on secondary battery. Resolution 0.1 volt. Accuracy ± 0.3%

Amps charging or discharging: With 500A/50mV shunt: 00.0 to ± 999 Amps. Resolution with 100A/100mV shunt 0.00-300 Amps, resolution 0.01 Amp. ±1% ± least significant digit.

Note: Maximum amps is often limited by the shunt capability: maximum current for a typical 500A/50mV shunt is about ±400A. For a 100A/100mV shunt about ±70 Amps. (Depending on shunt design and ambient temperature)

Watts: ±20,000 Watts. Resolution 3 digits, minimum of 1 watt. Accuracy ±1.5% ± least significant digit.

Amp-hours: Measurement accuracy: 0.00 to ±80,000 Amp-hours to same accuracy as amps.

Battery % Full: Measurement accuracy ±1%. Also measures overcharge. Typical system accuracy, if batteries are charged full at least every 5 days : typical ±5%. With "efficiency" set to suggested 94% the **Battery%Full** Display will be conservative (i.e. display a little lower than actual).

Meter Power requirement: About 30 mA when display is on and about 16mA when display turned off.

Efficiency factor adjustable: 60-100%

Battery capacity settable 10 to 10,000 Amp-hrs.

Serial Data: 5V output stream with all TriMetric real time data ASCII coded.

Charge criteria defined by: Filtered voltage above Vset. Filtered amps less than Iset. Time greater than Tset, all three adjustable. (Filtered time constant: 280 seconds). See Section 6.2 for detailed description.

Power Requirement: Power from main battery B1: 9-65V, 32mA with display lighted. 16 mA with display off.

Size: TM-2030-RV: Box is 4-1/4 high x 3 x 1-3/8 inch depth with 1/2 in. mounting tabs top and bottom. (10.8 x 7.6 x 3.5 cm.)
TM-2030-A: 4-1/2 x 4-3/4 panel with circuit board 7/8 (max) in. deep. (10.8 x 12 x 2.2 cm.)

History data: retained in memory when power turned off

- **●Cumulative amps discharged during battery lifetime** (0-999,000 amp hours) to measure battery wear

  for last 5 charge/discharge cycles the following are recorded:
  - **●Hours ago since end of cycle**
  - **●Length of cycle** (hours)
  - **●Amp hour efficiency factor for each complete cycle** (to show charge efficiency of battery system)
  - **●Minimum voltage** for each cycle.
  - **●Minimum battery %Full** for each cycle

  For the last 5 days:
  - **●Maximum voltage each day**
  - **●Amps value:** intended to show how close to "charged" the battery system got
    When maximum voltage greater than charged setpoint volts: shows minimum amps.
    When maximum voltage less than charged setpoint volts: shows amps at maximum voltage
  - **●Maximum value percent charge returned compared to most recent discharge**

6.2 How the TriMetric keeps track of battery % full . How it determines that the batteries are charged.

How the TriMetric uses "Capacity (P3)", "charged setpoint volts (P1) , "charged setpoint amps" (P2) and "efficiency factor" (P10).

Initially when the TriMetric is first turned on it does not have any way of knowing how full the battery is. The "battery % full" display will start out blank : "---" Here are the steps used to determine the % full

1.First the battery must be initially charged fully. When the TriMetric is charging, there are several choices you can select for what defines "full charge".

A: If P7 is in level L1 or L2: Filtered value of Volts must exceed value programmed in P1 and filtered (charging) amps must be less than value in P2. If P2 is set to OFF, then amps value is not considered.

B: If P7 is in level L3: In addition to above requirement, the above needs to be true for the total time set in P14.

C: If P7 is in level L4: Either condition 2 above either condition 1 must hold for time in P14 or percent overcharge must exceed setting in P20.

: Then When the charger is charging the battery, the TriMetric senses that the battery is charged when two conditions are met: (1) battery voltage must exceed the "Charged setpoint voltage" (which you set by Program P1.) and (2) the charge current (amps) must decline to below the "Charged setpoint amps" (which you set by Program P2). It is also (optionally) possible to set a third condition: that the above conditions must be sustained for a minimum time which you set by Program P14. Note that *filtered* versions of "Battery voltage" and "battery amps" are used, described in step 5, below.

2. When the above occurs the TriMetric then declares the battery "charged" by flashing the "charging" light, .and, resets the "Days since charged" to 0.

3.When the charging is finished, and the batteries start to discharge again then the "Amp hours from full" is reset to 0.00, and Battery%Full is reset to 100%. (This assumes that the "auto reset" is on, which is always the case in Level L1 or L2. It may be turned off if desired in Level L3)

4. As the battery discharges, the TriMetric "amp hours from full" gradually go negative at a rate depending on the number of amps, and go positive when charging. For example if the batteries are discharging with "amps" = minus 10.0, the "amp-hours from full" display gradually *decreases* by exactly 10 for every hour that goes by. Similarly, when amps are *positive* 10 amps (charging) the "amp-hours from full" display gradually increases by *almost* 10 amps for every hour. The "almost" has to do with "charge efficiency factor" which can be adjusted by program P10. If the efficiency factor is set to 100%, the amp-hours will go up by *exactly* 10 per hour , however if the efficiency factor is 94%, the "amp-hours from full" display goes up by only 94% of 10, or 9.4 amp-hours for every hour. The purpose of this is to account for the fact that you don't get as many amp-hours out of the battery as you put in, so that the TriMetric "amp-hours from full" display will give a reading of amp-hours which reasonably closely estimates how many amp hours have been removed.

5. It was mentioned in step 1 above that *filtered* values of "volts" and "amps" are used to judge when the batteries are charged. This means that before using these values they are filtered so as to be only very slowly responsive versions of "volts" and "amps" are used, so that quick variations of voltage or current don't give a false "charged" signal. (They are filtered with a time constant of about 4.8 minutes.) These "filtered" versions can be viewed, if desired, by putting the TriMetric in Operating Level L3—when viewing the "volts" or "amps" display you will see the "filtered" version by holding down on the "RESET" button.

The "battery % full" reading of the TriMetric just puts the "amp hours from full" number in a different form, which depends on the "amp hours "Capacity" number that has been programmed in to the TriMetric in program number P3. When the battery is full and the "amp hours from full" value is 0 then the Battery% full will be 100. When the battery is depleted so that the "amp hours from full" goes to a negative value equal to the "capacity" programmed in P3 then the Battery% full goes to zero.

6.3 Using History Data

for diagnosing battery system problems. The last page of these instructions has a chart for recording these. There are a total of 36 historical data that are recorded. History data falls into 3 groups: The data (x) below ranges from 1,2,3,4 and 5, going from (1) most recent to (5) earliest.

Group 1: **H1.1: Cumulative Lifetime Battery (discharging) Amp hours** , which is the only item in the first group.

Group 2: **H2.x – H6.x. Charge/discharge cycle data**. There are 5 types of data for each of the last 5 charge/discharge cycles, so there are 25 in this group.

Group 3: **H7.x: Max voltage and H8.x: minimum current, and H9.x: how much overcharge was delivered compared with previous discharge, for each the last 5 days**. Total of 10 items in this group. x ranges from 1 to 5, going from 1=yesterday to 5=five days ago.

Group 1 (only 1 item): H1.1: Cumulative Lifetime Battery (discharging) Amp hours: Displays how many amp-hours have been withdrawn from the battery system over its lifetime. This number starts at 0 when manually reset which would usually be at the time of initial installation of the batteries. See reference to "RESET" button in figure 1 for how to do this. Every time the value of amps is negative (charge is leaving the battery) the display counts "amp-hours" down. But it does not change when battery is charging (amps is positive.) . It analogous to a car odometer to tell how much service the batteries have seen

When the batteries are replaced, this number can be noted to measure the total energy which your batteries have delivered in their lifetime, which can be used to evaluate performance of the batteries and the level of care which they received. In case of power interruption to the meter you will only lose a maximum of 3 hours of this data--because this data is automatically stored every 3 hours. This number can be displayed to -999,000

amp hours, which is longer than most battery sets would be expected to last. (Should it ever reach this high it should be reset--since it does not, just roll over to zero by itself after 999,999.)

Often battery life of "deep cycle" batteries is rated by the number of discharge cycles it will undergo without failure--however this usually assumes a fairly complete discharge during each cycle, followed by complete recharge. The life of deep cycle batteries is increased if the discharge depth is less--in fact the number of cycles of life is inversely related to the depth of discharge of each cycle--so if you discharge only half the amount during each "cycle" the battery will last about twice as many cycles.

Another way to look at this is that when buying batteries you have a choice whether to double the number of batteries in your battery set—which will reduce the average cycle depth of discharge to one-half. A less deep discharge should result in longer life for the set: but the question is will you get double the life if you did that—which would be required to break even on the additional investment. Typically the life would increase to about double, so there would be little cost benefit. (Of course you'd get more days of autonomy.) . But in a vehicle it would add extra weight. This measurement made by the TriMetric is a way of getting quantatative data on these kinds of questions.

Group 2 (25 items): H2.x – H6.x Charge/discharge cycle data for last 5 cycles. "x" goes from 1 to 5. Each discharge/charge cycle begins at the time the battery is "fully charged" and ends at the next "full charge"—for more precise definition see section 6.2: How the TriMetric keeps track of battery % full. The cycles begin and end exactly at step 3 in that section. Each item below records data for (up to) the five most recent complete cycles.

H2.1 through H2.5: How many hours ago that the cycle in question ended (H2.1 most recent. H2.5 oldest data).

H3.1 through H3.5: Length of the cycle in question, in hours. You can see how much time goes by between full battery charges. Frequently charging them helps keep them from permanently losing capacity. It's also useful to observe that the TriMetric "charged" setpoints (P1 and P2) are properly set to register the cycles—otherwise the "Battery % full" display will not be correct.

H4.1 through H4.5: Total charge efficiency over each cycle in question, which shows how much energy your system wastes over each cycle—which from a system efficiency standpoint you would like this to be close to 100%. All "charging" amp hours are accumulated in one register, and all "discharging" amp hours are accumulated in another for the entire discharge/charge cycle. To get this charge efficiency number, the "discharging" amp hours are divided by the charging amp hours, and result expressed as a percentage. If batteries were perfect, and you got out exactly as much energy as you put in during one cycle—and if the cycles were measured exactly, this number would be 100%. But typically you lose some energy from self discharge, and also from the beneficial overcharging that occurs when the batteries are being fully charged when the batteries are gassing, so this number will be usually less than 100%. Well charged batteries would show a value of 85-90%, which indicates that 10-15% more charge has been added than last taken out. If this number is an excessively low, that would indicate possibly that batteries were losing a lot more energy than they should, or also it could indicate that something is not wired up correctly to the shunt, for example a load is not being seen by the TriMetric on the "amps" display. Or if it shows up often or always as a negative number this would surely also indicate a miswiring to the shunt (charge controller or charger that isn't getting measured on the amps display, for example.) There should be some consistency in the readings. Although the value is ordinarily less than 100%, they can even occasionally be greater than 100% when the temperature of your batteries drops from beginning to ending of a cycle—in this case they will accept less charge at lower temperature to appear "charged", making them look more efficient than they really are. For the same reason, when the temperature rises over a cycle you should find this number lower than usual, as would also be the case after a battery equalization cycle.

H5.1 through H5.5: M**inimum voltage** during each cycle. This can show if the batteries are being run too low before being recharged.

H6.1-through H6.5: Minimum Battery % full during each cycle. This is another check to see that the batteries are not being run too low before being recharged.

Group 3 (15 items) H7.x – H8.x. Volts and Amps data on each of previous 5 days:

H7.1 through H7.5: Maximum (filtered) battery volts on last five days. (see 6.2.5 for definition of "filtered")

H8.1 through H8.5: **(Filtered) amps value:** which depends on whether H7 maximum voltage on that day was **less** or **greater** than the "charged voltage" setpoint programmed in program P1.

If the H7 (maximum filtered voltage) on a particular day is **less** than the "charged voltage" setpoint:

Then the amps value (for that day) is the (filtered) amps value at the moment that the maximum voltage occurred.

If the H7 (maximum filtered voltage) on a particular day is **greater** than the "charged voltage: setpoint:
Then the amps value is the minimum (filtered) amps during the time that the volts is greater than the "charged voltage" setpoint.

The last two items are intended to show how close to "charged" the battery system got on that day. To check if the "charged" criteria were met in the most recent 24 hour measurement period, see if H7.1 volts was **greater** than the volt setpoint value in program P1, and that the H8.1 amps was **less** than the amps setpoint in P2. This will tell you whether the voltage didn't get high enough, or if amps didn't get low enough. Then you can go back up to four more days, to see whether or not the "charged" criteria were met on each of those days. The charge controller may be set improperly—or the TriMetric sepoints are wrong.

It is particularly useful if it appears the "days since charged" has a suspiciously high number of days, indicating that the system is not reaching the "Charged' parameters when it should. Remember that the meter must reach the filtered values of volts and amps, which is not exactly what the regular display values are. See section 6.2, step 5 for a description of "filtered", and how to observe them.

H9.1 through H9.5: % of charge returned compared to last discharge: According to many battery experts, liquid electrolyte lead acid batteries should be charged to 110-115% more than the last discharge to insure they are well charged. AGM batteries can be charged less to 104-107% of previous discharge.

6.4 Further description of each programming function.

Instructions for observing and changing these is in section 5, Table 2.

P1 and P2: "Charged" setpoint voltage and **"charged" setpoint amps.**

Purpose of data: The "charged" voltage (P1) and amp(P2) setpoints provide information the TriMetric needs to determine when your battery set is "charged". Details are given in section 6.2. **The amp setpoint (P2) is now entered as a percentage of P3 (unlike with the TM2020, or TM2025, when the amps was entered directly.)**

About voltage and current "charged" setpoints: Of these two setpoints, the "voltage" setpoint is the most critical, and the "current" setpoint less so. If you have only low current charging sources you can set the current setpoint to "OFF"—however both should be used if at least one of your chargers is a high current charging source such as a generator charger or inverter/charger. More specifics follow.

Choosing "charged setpoint volts": Section C1 of the "**Installers instructions for TriMetric TM2030" has instructions on determining these parameters.** Also more information is given in section 7 of these instructions. At risk of saying too much we also offer also the following: For a 12 V lead acid battery system, the **voltage setpoint** will usually be between 14.0 and 14.8 volts. Double these numbers for 24V systems or multiply by 4 for 48V systems. As pointed out in Section 7, your chargers must be set according to information from the battery manufacturer. Once those are set, the TriMetric voltage setpoint should be 1% or so lower than the charger settings. If this is done the TriMetric "charged" lamp comes on just before the charging system decides that the batteries are charged and stops charging your batteries. If you have two or more chargers, such as solar and generator, both chargers would normally be set to charge to the same voltage, and the TriMetric should be set with the voltage low enough for either one to reach when the batteries approach full charge.

Choosing the "charged setpoint percentage amps": IMPORTANT: The method of setting this has been changed from the older TM-2020 or TM-2025. If you have generator or other charger that has high charging current capability it becomes important to also set the "charged setpoint amps" in the TriMetric. This is because a high current charging source can force the battery voltage to rise and meet the "charged voltage" setpoint even though the batteries are not yet well charged. With such a charger, once the voltage reaches its maximum "bulk voltage" the charging current (amps) will start out high, then *gradually reduce* as the batteries become more charged. Proper adjustment of the "current setpoint" will insure that the TriMetric will not consider the batteries "charged" until the charging current goes below the setpoint amps. The lower you set this value, the more "charged" the battery must be before the TriMetric will declare the battery to be "charged". To set this value you must know the amp-hour capacity of your battery system which has been set in program P3. We often suggest value for the "current setpoint" setting that is 2% of C, where C=battery system capacity in amp-hours is programmed in P3. For example if your battery set has a capacity =700 amp hours, then amps setting could be 2%, or 14 amps. Better charging would result using 1% of C, for the battery to be really charged—however this may require more solar time (for example) than is usually available. **New for the TM2030 enter this percentage directly into program P2; from 1.0 to 10.0%**. This will enter an amps value that is equal to this percent multiplied by what you entered in P3. After you enter the current setpoint the TriMetric will require that both the filtered voltage setpoint be *equal or exceeded*, and the filtered current (amps)

value be *less* than or equal to the current setpoint before the TriMetric will indicate that the batteries are "charged". The "filtered" values are very sluggish versions of these parameters—explained in Section 6.2 step 5.

Usually in float mode? Another possibility we should address is if your charging system stays much of the time in "float" mode, which may be true for a "line tied" system, or a battery system in an RV that is only occasionally used, with its battery usually connected to a charger that maintains it at "float" voltage . With a lead-acid liquid electrolyte battery the "float" voltage may be 13.4 volts (for 12V system) For a system that is usually in "float" mode, the TriMetric voltage setting can be just below 13.4, (or whatever the float voltage is) and the "amps" setting can be for some low value, such as C÷90 or so, or to a value which the "amps" would only go below during the "float" condition. Then the TriMetric will reset only after the "float" condition is attained.

P3: Battery assumed capacity. This is the basis for calculating the Battery % full number. The Battery % Full is calculated as = (Capacity – AmpHoursFromFull) ÷ (Capacity), expressed as a percentage. The Capacity (in amp hours) is what you program in here. The AmpHoursFromFull is the value shown on the secondary display group. Also see the "Installer's instructions for TriMetric TM-2030" section C, under program item P3.

P4: Watt/Amps choice. Select which you prefer as your primary choice. Explained on Table 2.

P5: Days before "time to recharge" Battery reminder. Explained in section 2.2.1 and Table 2.

P6: Days before "time to equalize" Battery reminder. Explained in section 2.2.2 and Table 2.

P7: **Operating Levels** This allows switching to any of three Operating levels: L1=simplest, and OK for most users. L2= All of L1 plus data logging information. L3 and L4= All of L2 plus additional programming flexibility, as shown below.

The following program items are available when the TM-2030 is switched to L3 or L4 level. (use P7 to switch)

Program modes P15, P16, P20, P21 and P22 are only used only with the optional SC-2030 charge controller, and are described in the instructions for the SC-2030.

P9 and P13: These set the "low battery" alarm level. The **audible** battery alarm will begin sounding when the main "Battery % full" display equals or is less than the value you program here OR if the (filtered) "volts" goes below the voltage set in program P13 (see below). For a 12V system a typical setting for P9 might be 50%, and for P13: 11.5 volts . The audible alarm will not activate when P9 is set to 00. When the alarm comes on it may be silenced by the **reset** button--but the alarm's presence will still be indicated by the flashing "BLo" in the display.

P10 Assumed charge efficiency factor:

Purpose of data: "charge efficiency factor" See section 6.22, part 4 for an explanation of "charge efficiency factor".

Choosing values of "charge efficiency factor": In the "L1" mode this value is fixed at 94%. If you wish to adjust it to a different value you will need to switch to "L3" mode. The actual "charge efficiency" factor for lead acid batteries *while they are not at the top of charge* is generally higher than 94%, so this will usually give a *conservative* value for "amp-hours from full"-- that is the meter will generally slightly under-estimate the "% Full" value for the batteries which will give a useful practical result for knowing state of charge.

Optional technical note: Some people familiar with batteries will be surprised that the suggested "efficiency factor" is as high as 94%. Without going into all the details here, there are two reasons for this: (1) The number entered in the TriMetric is not true battery efficiency, or *energy* efficiency, (which is often quoted at 70-80% for lead acid batteries) but *charge* efficiency. Charge efficiency (the ratio of total amp-hours you get out divided by total amp-hours to charge the battery) is always greater than energy efficiency. (2) What is entered in the TriMetric is not even the overall charge efficiency of the battery, but the charge efficiency while the battery is *not* at the top of charge, and not gassing. A battery is not charge efficient while at the top of charge, so if this part is excluded the battery is very charge efficient. (We have measured this to be 95-98% with Trojan wet cell batteries.)

For the perfectionist only: Practical utility doesn't demand perfection--and the reality of changing battery temperature makes this difficult. But if you wish to try and your batteries are fairly constant in temperature: the ideal is that the TriMetric "% full" should show 100% at the time that the *charging system* has fully charged the batteries and the "charged" lamp flashes on the TriMetric, as explained in section 6.-2.-2.) If you find that the % reading is somewhat **below** 100% after the charging system has fully charged your batteries, then you could **increase** the efficiency factor. If you find that the numbers are going **above** 100% when your charging system has finished charging, then **decrease** the efficiency factor. But note that if the battery temperature went up since the last "full charge" was reached, the "amp-hours" will be somewhat negative the next time reaching "charged." And if temperature went down, they'll be somewhat positive.

P11: Shunt type: This must be set according to the shunt type you have. This determines the sensitivity of the "amp" input to the TriMetric, so that it reads correctly for the shunt you have. If your "amps" readings appear to be off by a factor of 10, the most likely cause is this is not set correctly for your shunt.

Choosing value of "shunt type". At L1 level this is fixed at the 500A/50mV shunt. If you have a 500A/50 mV shunt is specified by " **Sh H** . ("High current shunt) If you have a "100A/100 mV" shunt, you should enter **Sh L** ("**L**ow current shunt"). Only the *ratio* shown is important to the TriMetric, so that from the TriMetric's point of view a 200A/200 mV or 300A/300 mV shunt is equivalent to a 100A/100mV shunt.

P12: **Automatic reset on/off** The "automatic reset" is described in section 6.2, step 3. It is usually on, but it may be turned off if the meter is used in a different application where you don't ever want the amp hours to reset by itself.

P13: Battery Low Reminders setpoint::. This allows you to set the level at which the "low voltage battery reminders" will flash. It also sets the audible low battery alarm as described in section P9 above. Set the value in volts that need to be attained for the "**B.Lo**" reminder to light. Also see section 2.3

P14: "Charged" minimum time setting This is an additional condition that can be added to the "volts" and "amps" charged criteria that are specified in program numbers P1 and P2 before the batteries are certified as "charged". You can require that the P1 and P2 parameters must be valid for te uninterrupted time period (in minutes) selected by the value you place in P14. It is adjustable in increments of 1/10 hours, from 0 to 5 hours. Also see section 6.2 step 1.

P17: Time of Recording for Daily history data: This applies only to the recording of the H7 and H8 logged data, which records maximum voltage and a value of current during each day (24 hour period). The time placed here will define the daily end time for these measurements. Typically they would be set so they occur in the middle of the night. The time placed here is the approximate number of hours until the time occurs. So if it is 10PM, and you want the day's data to be recorded at 1AM, you would enter "3" hours here.

P18: Voltage calibration: This is the "voltage calibration" adjustment if the voltage shown is not exactly correct. This should not be necessary to adjust—but if you find you need or want to—follow these two steps.

1. Get a multimeter that you know to be accurate. Carefully remove the TriMetric panel from its box to gain access to the back of the unit. With the multimeter measure "volts" between the "G1" and "+" terminals that are on the back of the TriMetric circuit board. Of course you need to be connected to a voltage source that is stable. (If you want to nit pick, like we do at the factory, you should use a voltage that is just between two 1/10 volt readings—for example we use 29.95 volts.)
2. Switch to the P18 Program, and put it in the "program" mode (3 lights flashing). Observe "correct" value on the multimeter--then push and continue to hold "RESET" down until voltage on the TriMetric display jumps higher than the multimeter reading. Release "RESET". Then successively push "RESET" with short pushes to gradually bring the voltage down until it is agrees with your multimeter.

P19 Program factory values. This just sets in all the default (factory) values in all the program locations at once—so it may erase any data you have put in. Hold down the "RESET" button for several seconds until this occurs.

7. Important information about battery charging to keep from killing your batteries

Even if you abuse your batteries they will probably work just fine—for awhile. By knowing how to care for them you can extend their life to maximize their return to you.

1. Charging to correct voltage. Charging for sufficient time. Charging at frequent intervals.
2. Not often letting them become totally discharged, or left very long in a discharged condition.
3. For liquid electrolyte batteries, maintaining the water level always above the internal plates.

The most important thing to maintain your batteries is to charge them to correct voltage and current and "often". We will try to define both. The most common "battery crime" for which the penalty is having to replace your batteries too soon, is charging with insufficient voltage, or not charging long enough to get them fully charged.

Charging voltage: One of the most important numbers to know about your batteries if you wish to maximize their life is the "Recommended **absorption charging voltage**" for the batteries. (This is usually given for a battery temperature of 25 degrees C or 77 degrees F.) The typical well designed charger or charge controller used with "deep cycle" batteries (which are the type of batteries designed to be periodically discharged and charged) starts by charging fairly fast (at a high rate of amps), but the battery voltage may start out low if the battery is not well charged. Charging causes the battery voltage to gradually rise over a period of possibly hours—but as soon as it rises to the "absorption charging voltage" the charger is supposed to be smart enough to stop allowing the voltage to rise higher than this to avoid damage to the batteries—although the charger will continue to send current to the batteries at this voltage while the current (amps) slowly declines. **The manufacturer of the batteries should specify what this voltage should be. Or ask the dealer who sold them to you who hopefully should know. Unfortunately many do NOT know.** This voltage will be slightly different for different types of batteries: for example, 12 volt liquid electrolyte lead acid batteries will have an absorption charging voltage of about 14.4 -15.0 volts. AGM or Gel batteries will have a lower voltage, perhaps at 13.9-14.4 volts. (Multiply these by 2 or 4 for 24 or 48V systems.) Your charger(s) must then be set to the **battery** manufacturer's (not the charger manufacturer)

recommended voltage. If the voltage is too low or too high, battery life will be impaired. It is especially important to get this correct for the AGM or Gel types—not least because they are even more expensive than liquid electrolyte types. Ideally you can adjust this voltage on every charger (or charge controller) you have. Unfortunately some chargers do not leave much choice--and some do not charge to high enough voltage, and then you will have to settle for whatever the charger determines, at possible detriment to your batteries. If you have multiple charging sources, for example if you have a stand alone generator, a charger or converter, and also solar, or perhaps also your engine alternator, **ideally all chargers should be set identically** according to what the **battery** manufacturer recommends. Often that's not possible (say, for engine alternator) then the voltage value for that charger should be lower—however then you should have another charger to back that one up to periodically charge to the proper absorption voltage if you want to maximize battery life. Although some chargers just have a switch that says "AGM" or "Liquid electrolyte" to set this voltage, it is useful for you to know this actual voltage number since you now own a TriMetric, to check that the charger is really charging correctly. If all chargers are not set correctly you may be buying replacement batteries before you expected.

Battery temperature: If the battery temperature varies considerably the charging source should adjust its voltage to temperature. A well designed charger will have a temperature sensor, and adjust its voltage a little higher at cold, and lower at warmer temperatures. As mentioned above, the absorption charging voltage is usually given for a battery at 25° C. (77° F.)

You can use the TriMetric to determine what your charger is adjusted to by watching "Volts" as the charger is charging the batteries—and eventually you should find that the voltage does not rise any more as the batteries approach full charge. An easier way which doesn't require that you constantly monitor the meter is to use the "History data" (see Section 4, item H7. and H8.)

Charging for sufficient time: Not only must the voltage be high enough, but it is the nature of battery chemistry requires that the passage of some time at the "absorption voltage" to fully charge. So this means not only adjusting the voltage correctly as mentioned above, but charging for enough time to get the battery well charged. There are three ways commonly used to measure this. (1) charge at absorption voltage for a set time, sufficiently long: from 1-8 hours. (2)Probably better is instead of waiting a fixed amount of time, to do it long enough for the charging current (in amps) to drop to a low enough value—as the current gradually drops with time. (sometimes called the "return" value). This is what the TriMetric measures when it makes a judgment about whether the battery is charged. A practical value for this is to take the total "amp hours" capacity of the battery system and divide by 50 to 100 to get an "amps" value to which the batteries should reduce before charging is completed. We often suggest capacity ÷50, not because it is absolutely ideal, but it is a reasonable compromise for getting them charged in a reasonable amount of time. (3) Often considered the best way is to return a percentage more of charge when recharging--for liquid electrolyte batteries returning 10% to 15% more than was just previously discharged is often recommended--for AGM batteries the number is 104%-108%.. Very few chargers use this method, but our SC-2030 solar charger has this capability (when paired with the TM2030 monitor). (4) The "classic", but rather inconvenient method which works only for "liquid electrolyte" batteries is to use a hydrometer to measure the specific gravity of the battery acid of each cell to see that it comes up to a high enough value as specified by battery manufacturer.

Why solar panels can be good for batteries: Even if you don't get all your energy needs from solar, these are often a very useful complement to your engine chargers to reduce the amount of engine time required to charge and yet get a good charge on your batteries. Use your engine charger(s) to begin charging when your batteries are low, which is when they absorb energy at a higher rate, making more efficient use of your engine. Then once they approach full charge turn off the engine and let the panels deliver a slower, but much longer charge to get your batteries well charged without having to run a generator for a long time.

Charging to full sufficiently often: It doesn't hurt to discharge a "deep discharge" battery to 50% or less—that's what they are designed to do—but lead acid batteries should not be left uncharged for a long period. The reason is that if the lead sulfate reaction product that is produced as the battery is discharged is left too long it changes its form so as to be harder to convert back to its "charged" state—lead, lead dioxide and sulfuric acid--so you will not be able to retrieve as much energy from the batteries. We suggest charging to "full" at least every five days or so. To help, the TriMetric has a "battery reminder" function to remind you to charge the batteries fully after a certain number of days have elapsed in which they have not been brought to full (which you set using Program number 4). Once you fully charge them the flashing reminder will cease. See Section 2.2.1. Also, the "days since charged" display on the "secondary displays" page 3 will tell you how long it has been since they have been fully charged.

"Equalization" refers to a process of occasionally overcharging your batteries--which is usually recommended by manufacturers of "wet cell" lead acid batteries--but, however is *usually not recommended for "AGM" OR GEL sealed lead*

acid batteries, and can damage these types. The Trojan battery company, for example, recommends that their wet-cell batteries be equalized every 1-2 months. This helps to completely recharge the battery--which helps maintain the battery capacity. Some charge controllers, or battery chargers have an "equalize" mode which is controlled either manually or automatically. This TriMetric function is intended for use primarily for systems that require manual equalization--and reminds you to perform this after the programmed time. Placing the charger in "equalize" mode involves extra charging *after* the batteries have reached the "charged" criteria which allows the voltage to rise extra high for a period of time--for example the Trojan Battery Co. recommends charging to 15.5 volts (for 12V systems--double this for 24V systems) and keeping the batteries at that level for 2 hours. Other manufacturers may have different recommendations. It is usually advisable to check water levels in the batteries after equalization, as it causes some water loss. **After equalization has taken place you must manually reset the "days since equalized" display** (by pushing "reset" when the "days since equalized" extra data is displayed)**--this does not take place automatically.** This will turn off the "time to equalize" reminder, which will reactivate only after another equalization period has elapsed.

For "liquid electrolyte" batteries: Every month or so check the water levels in the battery cells to make sure that the water covers the plates. It is not good for the batteries if the level drops below this level.

Copy this table and use it for recording the TriMetric TM-2030 History data. This data can be helpful to a technician trying to diagnose a problem with your system, or to verify that it appears to be operating normally. Also copy the data from program modes P1, P2 and P3 and copy it to the second chart at bottom:

To access this data:
1 Be sure "Operating level" is set to L2 or L3. (Use program mode number P7)
2. Push and hold "SELECT" down and watch display (left) for "H", then quickly release SELECT. If you miss the first time, just repeat until you succeed.
3. You will now observe data at "H1.1" on table. You can record this data in the box on this table just under "X.1 ". (near top left table).
4. Push "SELECT" to move down one row on table.
5. Push "RESET" to view and record all data moving to right in table. (Except for H1.1).
6. Push "SELECT" to move down one row, and then repeat steps 5 & 6 until table finished.

Date of record_____

	History Number	X.1 Most Recent	X.2	X.3	X.4	X.5
	H1.1 Cumulative A-hr	H1.1				
5 Charge-Discharge cycle info	H2:Hours since cycle ended	H2.1	H2.2	H2.3	H2.4	H2.5
	H3: Length of Cycle-hours	H3.1	H3.2	H3.3	H3.4	H3.5
	H4:Amp-hour efficiency %	H4.1	H4.2	H4.3	H4.4	H4.5
	H5: Cycle Low % Full	H5.1	H5.2	H5.3	H5.4	H5.5
	H6: Cycle Min. volts	H6.1	H6.2	H6.3	H6.4	H6.5
5 day Log Info	H7: Day's Maximum Volts	H7.1	H7.2	H7.3	H7.4	H7.5
	H8: Day's Minimum Amps	H8.1	H8.2	H8.3	H8.4	H8.5
	H9: Day's percent amp-hr charge	H9.1	H9.2	H9.3	H9.4	H9.5

To aid in system analysis, view values programmed in Program modes P1, P2 and P3 and record them here:

Program mode item	Value
P1: voltage "charged" setpoint	Volts
P2: current "charged" setpoint	Amps: % of P3 value
P3: Battery capacity setting	Amp-Hr